rainfall, as in the following table, we may perceive a clearer connection between the rainfall and the sugar crop than was shown in our previous article:

Years of harvest.	Total sugar crop.	Rainfall during growth.
	Kilograms.	*Inches.*
1886	102,376,271	57.25
1880	119,731,492	68.39
1884	127,784,339	75.55
1885	115,299,039	77.13
1881	117,809,610	78.68
1893	139,751,810	80.39
1883	120,396,858	84.03
1887	124,073,140	86.18
1894	113,793,319	88.11
1890	130,220,273	88.94
1895	142,645,722	96.11
1891	113,813,075	96.61
1892*	68,718,573	98.78
1896	152,677,973	108.58
1889	124,564,951	108.71
1882	116,719,997	118.37
1888	132,172,988	125.40

* Destructive hurricane.

By taking the means of these figures in groups we see that there has been a steady increase in the sugar crop which averaged 119 millions during the first four years and 137 millions during the last four years, which increase is undoubtedly due to an increase of acreage. On the other hand, the average for the four years of the least rainfall is 116 millions, and for the four years of greatest rainfall 131 millions. In these latter averages the secular increase, due to acreage, has little or no influence, and the difference of 16 million kilograms may be attributed to the increase of average rainfall from 70 inches to 115 inches during the growing season, so that an increase of three inches in the rainfall brings an increase of 1 million kilograms in the crop.

CORRECTION.

It is said that the Editor seems to have been unnecessarily severe in some remarks on page 316 of the MONTHLY WEATHER REVIEW for July. He was trying to show how to define the expression "very violent thunderstorm," so that the record would show whether the violence referred to the thunder and lightning, or the wind, or the rain or hail. He unintentionally misquoted the original report from Elgin, Ill. (where the measured rainfall was 0.43 inch), but he did not intend to say that a storm having so small a quantity as 0.043 inch might not be a very violent storm. If the expression "violent storm" is not misleading, it is, at least, possible to remove its indefiniteness by stating wherein the storm was violent.

The observer writes to say that 0.43 is the correct rainfall, "and the recollection of that stormy half-hour will linger in the memory of thousands in this city for a long time, so, also, will its marks continue on our shade and forest trees."

We infer that the measured rain fell within half an hour, which brings it up nearly to the standard of excessive rainfalls tabulated monthly by Mr. Henry in Table XI.

The Editor hopes that the observers will agree with him that it is better for him to venture on an occasional critical remark than not to remark at all.

INSTRUCTION IN RESEARCH.

It will be recognized by those who carefully consider the subject that progress in science consists not merely in the diffusion of what is already known, but in the actual increase of our knowledge. The grand structure called science has been the growth of many thousands of years. It is said that Pythagoras added to geometry his discovery of that important theorem which is now so familiar to every school boy, viz, that the square of the hypotenuse of a right-angled triangle is equal to the sum of the squares of the two sides. After geometry and algebra and arithmetic had been studied for two thousand years, the modern experimental sciences began to develop more rapidly. Newton and Galileo discovered the laws of forces and gave us the true basis for mechanics. Newton, also, made great strides in the study of the phenomena of optics. During the past century the names of Liebig in agricultural chemistry, Gauss in mathematics and magnetics, Kelvin in electricity, Clausius in thermodynamics, and a host of others each in his own sphere have become famous for the energy with which they have pushed their inquiries forward into the unexplored fields of nature. Our own land has had her Espy and Ferrel, but still stands in need of the help of many other equally sagacious investigators.

We hear much of the study of science in schools and colleges, and at last meteorology is also beginning to be appreciated as an important course of study; but can we be content to merely teach over and over again that which has been accepted as true? We are everywhere confronted with unexplained phenomena, with events that contradict all theories and hypotheses. We must hold ourselves open to conviction and ready to accept whatever new modification of old views may result from better investigations. But how shall we educate investigators?

A mistaken idea has widely prevailed that the investigator is a genius, born and not made; sent to us by the Creator, and not educated by human design. The history of German science has, however, shown that environment and training are as important as birth and inheritance. The whole system of education in the German universities has for five generations been directed to the development of the investigator as its highest product. Those who discover important new facts, laws, or principles have been rewarded with the highest places in the intellectual world of that nation. Those who feel that they have a desire or calling for scientific research are encouraged to study for the degree of doctor of philosophy, a degree that is only granted when the candidate has, by actual observation, experiment, or exploration, made some important contribution to human knowledge. The professors under whom he studies have, in their turn, made many similar contributions, and are well prepared to judge of the value of *his* work. Of course a considerable percentage of candidates fail to receive the desired degree of Ph. D., even after many years of persevering work; but still the German universities have, during the past seventy years, published over fifty thousand so-called "doctors' dissertations," embodying the results of the works of fifty thousand candidates. The consequence is that to-day Germany easily leads all the world in the amount and value of her contributions to human knowledge and the energy with which her students pursue the study of nature.

In a recent address by Sir Norman Lockyer (see Nature for October, 1898) he states that in 1845 in England there were no laboratories in the universities, no science teaching in the schools, no organization for training science teachers, and, he might have added, still less organization for training scientific investigators. The same was at that time true, approximately, of the United States, and in both countries the young men who wished to devote themselves to science were accustomed to resort to France or Germany to find the necessary educational facilities, stimulus, and companionship. Since those days both England and the United States have awakened to the necessity of encouraging scientific investigation and the training of investigators.

A great stimulus to the study of nature was given in America by the influence of Agassiz, at Cambridge, beginning with 1846, and by the opening of the Smithsonian Institution in 1847. Almost simultaneously independent work began at Philadelphia, Princeton, New Haven, Ann Arbor, Troy, Charlottesville, and possibly elsewhere.

The weekly journal Science, for August 19, 1898, says:

The development of the American university during the past twenty-five years may perhaps be regarded as the great achievement of the nation. The foundations laid at Harvard and at Johns Hopkins within the lifetime of those students now profiting from them have been built upon, until we have now a score of universities, as places for research, equal to Oxford, and half a dozen rivaling those of Germany. The American college, though founded upon the English system, was of native growth, and the university, based upon this college, though influenced by German methods, is distinctly national, while at the same time our different institutions show a marked individuality. The American university is definitely a place for research, where both teachers and students are engaged in research and in learning the methods of research. The results of the work of the students are in large measure summarized by the theses for the doctorates, and it is interesting to know what is the outcome of the past year's research.

It appears from a somewhat careful inquiry that 18 leading universities in 1898 conferred the degree of Ph. D. on a total of 234 candidates. The latter may be classified as those devoted to the humanities (91); to history and politics (38); to the sciences (105).

The weak point of the American custom in regard to these doctorates is that in many cases the theses are not published, so that we have no means of comparing either the candidates or the standards of the respective universities among themselves; but, in general, it is believed that heavier work is required of the candidates at Harvard and Johns Hopkins than elsewhere. We see from the preceding that the small force of men engaged in scientific research throughout the United States thus receives an appreciable addition every year. The editor of Science states that the distribution of these 105 theses, that is to say of the 105 scientific students, among the different sciences was as follows:

Chemistry	27
Psychology	18
Zoology	12
Mathematics	11
Physics	11
Botany	11
Geology	6
Physiology	4
Astronomy	3
Anthropology	2

Meteorology does not appear in this list. Its problems involve questions of astronomy, physics, and mathematics. The attainment of the degree of Ph. D. in the universities quoted by Science ordinarily means at least three years of general and again three of special work, the American university course is therefore longer, and, it is said, more thorough than the average course in Germany for attaining the same degree.

At the present time the fields of instruction and investigation are rapidly increasing. Meteorology is fully ripe for its share of attention. It is very desirable that the older men in the service who are studiously inclined should by teaching, or otherwise, contribute to the study of meteorology in the universities, just as they already have done in the schools and colleges. It is equally desirable that among the studious young men who are just entering the service, those who have a good foundation in mathematics and physics, should seek to attain the degree of "Ph. D. in meteorology" at the universities located in the cities where they are stationed. Any thesis prepared by a successful candidate for this degree would certainly be worthy of publication by the Weather Bureau. The present Chief has shown every willingness, and, indeed, a great desire to stimulate the intellectual and scientific growth of the corps. We should not be distinguished merely by our work but by our knowledge, and not by knowledge only but by our researches and our additions to knowledge.

Apropos of the above remarks Mr. F. O. Stetson, a graduate of the Massachusetts Institute of Technology, says:

Meteorology, like every other science, requires for its advancement careful study, original investigation, and research. This must be carried on by men familiar with the work already done in the same field, and acquainted with the principles of that and allied sciences; men whose mental equipment is at least equal to that of the college graduate who has devoted the major part of his time to the study of science. Those graduates who engage in original investigation are actuated by one or both of two motives; interest in their work, or the belief that additional learning or a doctor's degree will bring them higher salaries and larger incomes. It is probable that the first is the predominant motive in most cases. The average college graduate, if financially dependent upon his own exertions, is apt to be impatient at the time already consumed in preparation, and to consider that time and money spent in further study can bring no adequate pecuniary recompense. Our advanced student, then, whether fresh from "Class Day" or of more mature years, selects from his specialty that which has appealed most strongly to his fancy during his undergraduate course. Under these conditions it would be extraordinary if he chose meteorology. He may have completed the usual college course in physics, scarcely knowing that such a science exists. He may have diligently studied the laws of heat and the theories of gases, without learning of their connection with winds and rainfall. There is the chance that he may inadvertently do much for meteorology by the development of some interlinked branch of physics, but the progress of this science is heavily handicapped, owing to the fact that what is already known of it is not as yet generally recognized as a necessary part of the college curriculum. To those students whose graduate studies are solely for the benefit of their pocketbooks, meteorology is even less attractive. Many of this class expect to make teaching their profession, and it needs no mathematical demonstration to show that if a subject is not to be taught, no one will prepare himself to teach it.

Progress in meteorology will result from the continued teaching, over and over again and as widely as possible, of what is already known. As the elements of the science become more generally taught, it will appeal, as a fit subject for research, to an increasing number of graduate students of both classes.

INTERNATIONAL METEOROLOGICAL SYMBOLS.

In connection with the Circular of 1884, which is reprinted on page 312, MONTHLY WEATHER REVIEW, for July, Mr. A. L. Rotch calls attention to the fact that the thunder and lightning symbol was modified by the following resolutions of the International Meteorological Conference at Paris, 1896:

1. That the symbol T be added to the International Symbols adopted by the Congress of Vienna to indicate the days on which distant thunder has been heard, and conformably to the decisions of that Congress.
2. The symbol ≺ should be reserved for distant and diffused lightning, *wetterleuchten*, sheet lightning [or heat lightning.—Editor].
3. The symbol T≺ should indicate all the cases where both thunder and lightning have been observed.
4. In the résumés the number of days of thunderstorms shall be, as far as possible, taken out separately for each of the three cases.

THE SECOND WELLMAN POLAR EXPEDITION.

Mr. Walter Wellman, leader of the Wellman Polar Expedition of 1898, took with him, as meteorologist and second in command, Mr. Walter B. Baldwin, Observer, United States Weather Bureau. Mr. Baldwin sends the following short letter to the Chief of the Weather Bureau:

S. S. FRITHJOF, CAPE TEGETTHOFF,
FRANZ JOSEPH LAND, *August* 2, 1898.

I have the honor to report that since the departure of this expedition from Tromsoe, Norway, June 26, meteorological observations have been made on board the steamship *Frithjof*, as follows:

At 7 a. m., 2 p. m., and 9 p. m., on temperature of the air (dry and wet bulb), temperature and salinity of sea-water; pressure of air (Weather Bureau aneroids Nos. 1134 and 1135, and ship's aneroid with attached thermometer); and velocity, whenever possible, of wind; kind and movement of clouds.

Marine barometer No. 488, obtained from the Chicago station, was found to be out of order and could not be repaired in time to be taken along; I, therefore, left it in its case, in care of Consul Andrew Aagaard, Agent of this Expedition, Tromsoe, Norway. The two aneroids are in good order, and I shall be able to make use of the barograph in connection with them, and expect to obtain good results therefrom.